General

Guideline Title

Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults.

Bibliographic Source(s)

National Clinical Guideline Centre. Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults. London (UK): National Institute for Health and Care Excellence (NICE); 2014 Jan. 63 p. (Clinical guideline; no. 176).

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: National Collaborating Centre for Acute Care. Head injury. Triage, assessment, investigation and early management of head injury in infants, children and adults. London (UK): National Institute for Health and Clinical Excellence (NICE); 2007 Sep. 54 p. (Clinical guideline; no. 56).

Regulatory Alert

FDA Warning/Regulatory Alert

Note from the National Guideline Clearinghouse: This guideline references a drug(s) for which important revised regulatory and/or warning information has been released.

- December 14, 2016 – General anesthetic and sedation drugs : The U.S. Food and Drug Administration (FDA) is warning that repeated or lengthy use of general anesthetic and sedation drugs during surgeries or procedures in children younger than 3 years or in pregnant women during their third trimester may affect the development of children's brains. Consistent with animal studies, recent human studies suggest that a single, relatively short exposure to general anesthetic and sedation drugs in infants or toddlers is unlikely to have negative effects on behavior or learning. However, further research is needed to fully characterize how early life anesthetic exposure affects children's brain development.
- August 31, 2016 – Opioid pain and cough medicines combined with benzodiazepines : A U.S. Food and Drug Administration (FDA) review has found that the growing combined used of opioid medicines with benzodiazepines or other drugs that depress the central nervous system (CNS) has resulted in serious side effects, including slowed or difficult breathing and deaths. FDA is adding Boxed Warnings to the drug labeling of prescription opioid pain and prescription opioid cough medicines and benzodiazepines.
- March 22, 2016 – Opioid pain medicines : The U.S. Food and Drug Administration (FDA) is warning about several safety issues with the entire class of opioid pain medicines. These safety risks are potentially harmful interactions with numerous other medications, problems with the adrenal glands, and decreased sex hormone levels. They are requiring changes to the labels of all opioid drugs to warn about these risks.

Recommendations

Major Recommendations

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance.

- Recommendations are marked as [new 2014], [2003], [2003, amended 2007], [2003, amended 2014], [2003, amended 2007 and 2014], [2007] or [2007, amended 2014].
- [new 2014] indicates that the evidence has been reviewed and the recommendation has been added or updated.
- [2003] indicates that the evidence has not been reviewed since 2003.
- [2003, amended 2007] indicates that the evidence has not been reviewed since 2003 but minor changes were made in 2007 for clarification.
- [2003, amended 2014] indicates that the evidence has not been reviewed since 2003 but changes have been made to the recommendation wording that change the meaning.
- [2003, amended 2007 and 2014] indicates that the evidence has not been reviewed since 2003 but changes have been made that change the meaning.
- [2007] indicates that the evidence has not been reviewed since 2007.
- [2007, amended 2014] indicates that the evidence has not been reviewed since 2007 but changes have been made that change the meaning.

See the original guideline document for the definitions of terms used in the guideline.

Within this guideline children are defined as patients aged under 16 years and infants as those aged under 1 year at the time of presentation to hospital with head injury.

Pre-hospital Assessment, Advice and Referral to Hospital

Public health literature and other non-medical sources of advice (for example, St John Ambulance, police officers) should encourage people who have any concerns following a head injury to themselves or to another person, regardless of the injury severity, to seek immediate medical advice. [2003]

Telephone Advice Services

Telephone advice services (for example, National Health Service [NHS] 111, emergency department helplines) should refer patients who have sustained a head injury to the emergency ambulance services (that is, 999) for emergency transport to the emergency department if they have experienced any of the following:

- Unconsciousness or lack of full consciousness (for example, problems keeping eyes open)
- Any focal neurological deficit since the injury
- Any suspicion of a skull fracture or penetrating head injury
- Any seizure ('convulsion' or 'fit') since the injury
- A high-energy head injury
- The injured person or their carer is incapable of transporting the injured person safely to the hospital emergency department without the use of ambulance services (providing any other risk factor indicating emergency department referral is present; see recommendation below). [2003, amended 2007 and 2014]

Telephone advice services (for example, NHS 111 or emergency department helplines) should refer patients who have sustained a head injury to a hospital emergency department if they have any of the following risk factors:

- Any loss of consciousness ('knocked out') as a result of the injury, from which the person has now recovered
- Amnesia for events before or after the injury ('problems with memory') (Assessment of amnesia will not be possible in preverbal children and is unlikely to be possible in children aged under 5 years.)
- Persistent headache since the injury
- Any vomiting episodes since the injury
- Any previous brain surgery
- Any history of bleeding or clotting disorders

- Current anticoagulant therapy such as warfarin
- Current drug or alcohol intoxication
- There are any safeguarding concerns (for example, possible non-accidental injury or a vulnerable person is affected)
- Irritability or altered behaviour ('easily distracted', 'not themselves', 'no concentration', 'no interest in things around them'), particularly in infants and children aged under 5 years
- Continuing concern by helpline staff about the diagnosis [2003, amended 2014]

Community Health Services and NHS Minor Injury Clinics

Community health services (general practitioners [GPs], ambulance crews, NHS walk-in centres, dental practitioners) and NHS minor injury clinics should refer patients who have sustained a head injury to a hospital emergency department, using the ambulance service if deemed necessary, if any of the following are present:

- Glasgow coma scale (GCS) score of less than 15 on initial assessment
- Any loss of consciousness as a result of the injury
- Any focal neurological deficit since the injury
- Any suspicion of a skull fracture or penetrating head injury since the injury
- Amnesia for events before or after the injury (Assessment of amnesia will not be possible in preverbal children and is unlikely to be possible in children aged under 5 years.)
- Persistent headache since the injury
- Any vomiting episodes since the injury (clinical judgement should be used regarding the cause of vomiting in those aged 12 years or younger and the need for referral)
- Any seizure since the injury
- Any previous brain surgery
- A high-energy head injury
- Any history of bleeding or clotting disorders
- Current anticoagulant therapy such as warfarin
- Current drug or alcohol intoxication
- There are any safeguarding concerns (for example, possible non-accidental injury or a vulnerable person is affected)
- Continuing concern by the professional about the diagnosis [2003, amended 2007 and 2014]

In the absence of any risk factors in recommendation above, consider referral to an emergency department if any of the following factors are present, depending on judgement of severity:

- Irritability or altered behaviour, particularly in infants and children aged under 5 years
- Visible trauma to the head not covered in recommendation above but still of concern to the professional
- No one is able to observe the injured person at home
- Continuing concern by the injured person or their family or carer about the diagnosis [2003, amended 2014]

Transport to Hospital from Community Health Services and NHS Minor Injury Clinics

Patients referred from community health services and NHS minor injury clinics should be accompanied by a competent adult during transport to the emergency department. [2003]

The referring professional should determine if an ambulance is required, based on the patient's clinical condition. If an ambulance is deemed not required, public transport and car are appropriate means of transport providing the patient is accompanied. [2003]

The referring professional should inform the destination hospital (by phone) of the impending transfer and in non-emergencies a letter summarising signs and symptoms should be sent with the patient. [2003]

Training in Risk Assessment

GPs, nurse practitioners, dentists and ambulance crews should receive training, as necessary, to ensure that they are capable of assessing the presence or absence of the risk factors listed in recommendations above. [2003, amended 2007]

Immediate Management at the Scene and Transport to Hospital

Glasgow Coma Scale

Base monitoring and exchange of information about individual patients on the three separate responses on the GCS (for example, a patient scoring 13 based on scores of 4 on eye-opening, 4 on verbal response and 5 on motor response should be communicated as E4, V4, M5). [2003]

If a total score is recorded or communicated, base it on a sum of 15, and to avoid confusion specify this denominator (for example, 13/15). [2003]

Describe the individual components of the GCS in all communications and every note and ensure that they always accompany the total score. [2003]

In the paediatric version of the GCS, include a 'grimace' alternative to the verbal score to facilitate scoring in preverbal children. [2003]

In some patients (for example, patients with dementia, underlying chronic neurological disorders or learning disabilities) the pre-injury baseline GCS may be less than 15. Establish this where possible, and take it into account during assessment. [new 2014]

Initial Assessment and Care

Initially assess adults who have sustained a head injury and manage their care according to clear principles and standard practice, as embodied in the:

- Advanced Trauma Life Support (ATLS) course/European Trauma course
- International Trauma Life Support (ITLS) course
- Pre-hospital Trauma Life Support (PHTLS) course
- Advanced Trauma Nurse Course (ATNC)
- Trauma Nursing Core Course (TNCC)
- Joint Royal Colleges Ambulance Service Liaison Committee (JRCALC) Clinical Practice Guidelines for Head Trauma [2003, amended 2007]

Initially assess children who have sustained a head injury and manage their care according to clear principles outlined in the:

- Advanced Paediatric Life Support (APLS)/European Paediatric Life Support (EPLS) course
- Pre-hospital Paediatric Life Support (PHPLS) course
- Paediatric Education for Pre-hospital Professionals (PEPP) course [2003, amended 2007]

When administering immediate care, treat first the greatest threat to life and avoid further harm. [2003]

Attempt full cervical spine immobilisation for patients who have sustained a head injury and present with any of the following risk factors unless other factors prevent this:

- GCS less than 15 on initial assessment by the healthcare professional
- Neck pain or tenderness
- Focal neurological deficit
- Paraesthesia in the extremities
- Any other clinical suspicion of cervical spine injury [2003, amended 2007]

Maintain cervical spine immobilisation until full risk assessment including clinical assessment (and imaging if deemed necessary) indicates it is safe to remove the immobilisation device. [2003, amended 2007]

Make standby calls to the destination emergency department for all patients with GCS 8 or less to ensure appropriately experienced professionals are available for their treatment and to prepare for imaging. [2003]

Manage pain effectively because it can lead to a rise in intracranial pressure. Provide reassurance, splintage of limb fractures and catheterisation of a full bladder, where needed. [2007, amended 2014]

Follow at all times best practice in paediatric coma observation and recording as detailed by the National Paediatric Neuroscience Benchmarking Group. [2003]

Transport to Hospital

Transport patients who have sustained a head injury directly to a hospital that has the resources to further resuscitate them and to investigate and initially manage multiple injuries. All acute hospitals receiving patients with head injury directly from an incident should have these resources, which should be appropriate for a patient's age. (In the NHS in England these hospitals would be trauma units or major trauma centres. In the NHS in Wales this should be a hospital with equivalent capabilities.) [new 2014]

Training for Ambulance Crews

Ambulance crews should be fully trained in the use of the adult and paediatric versions of the GCS and its derived score. [2003]

Ambulance crews should be trained in the safeguarding of children and vulnerable adults and should document and verbally inform emergency department staff of any safeguarding concerns. [2003, amended 2014]

Assessment in the Emergency Department

Be aware that the priority for all emergency department patients is the stabilisation of airway, breathing and circulation (ABC) before attention to other injuries. [2003]

Ascribe depressed conscious level to intoxication only after a significant brain injury has been excluded. [2003]

All emergency department clinicians involved in the assessment of patients with a head injury should be capable of assessing the presence or absence of the risk factors for computed tomography (CT) head and cervical spine imaging listed in recommendations below. Training should be made available as required to ensure that this is the case. [2003]

Patients presenting to the emergency department with impaired consciousness (GCS less than 15) should be assessed immediately by a trained member of staff. [2003]

In patients with GCS 8 or less, ensure there is early involvement of an anaesthetist or critical care physician to provide appropriate airway management, as described in recommendations below, and to assist with resuscitation. [2003]

A trained member of staff should assess all patients presenting to an emergency department with a head injury within a maximum of 15 minutes of arrival at hospital. Part of this assessment should establish whether they are high risk or low risk for clinically important brain injury and/or cervical spine injury, using recommendations below. [2003]

In patients considered to be at high risk for clinically important brain injury and/or cervical spine injury, extend assessment to full clinical examination to establish the need to request CT imaging of the head and/or imaging of the cervical spine and other body areas. Use recommendations below as the basis for the final decision on imaging after discussion with the radiology department. [2003, amended 2007]

Patients who, on initial assessment, are considered to be at low risk for clinically important brain injury and/or cervical spine injury should be re-examined within a further hour by an emergency department clinician. Part of this assessment should fully establish the need to request CT imaging of the head and/or imaging of the cervical spine. Use recommendations below as the basis for the final decision on imaging after discussion with the radiology department. [2003, amended 2007]

Patients who return to an emergency department within 48 hours of transfer to the community with any persistent complaint relating to the initial head injury should be seen by or discussed with a senior clinician experienced in head injuries, and considered for a CT scan. [2003]

Manage pain effectively because it can lead to a rise in intracranial pressure. Provide reassurance, splintage of limb fractures and catheterisation of a full bladder, where needed. Treat significant pain with small doses of intravenous opioids titrated against clinical response and baseline cardiorespiratory measurements. At the time of publication (January 2014), intravenous opioids did not have a UK marketing authorisation for this indication. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Good practice in prescribing and managing medicines and devices for further information. [2007]

A clinician with training in safeguarding should be involved in the initial assessment of any patient with a head injury presenting to the emergency department. If there are any concerns identified, document these and follow local safeguarding procedures appropriate to the patient's age. [2003, amended 2014]

Throughout the hospital episode, use a standard head injury proforma in documentation when assessing and observing patients with head injury. This form should be of a consistent format across all clinical departments and hospitals in which a patient might be treated. Use a separate proforma for those under 16 years. Areas to allow extra documentation should be included (for example, in cases of non-accidental injury). Examples of proforma that should be used in patients with head injury are provided in Appendix O in the full version of the original guideline document. [2003, amended 2007]

Involving the Neurosurgical Department

Discuss with a neurosurgeon the care of all patients with new, surgically significant abnormalities on imaging. The definition of 'surgically significant' should be developed by local neurosurgical centres and agreed with referring hospitals, along with referral procedures. [2003, amended 2014]

Regardless of imaging, other reasons for discussing a patient's care plan with a neurosurgeon include:

- Persisting coma (GCS 8 or less) after initial resuscitation
- Unexplained confusion which persists for more than 4 hours
- Deterioration in GCS score after admission (greater attention should be paid to motor response deterioration)
- Progressive focal neurological signs
- A seizure without full recovery
- Definite or suspected penetrating injury
- A cerebrospinal fluid leak [2003]

Investigating Clinically Important Brain Injuries

The current primary investigation of choice for the detection of acute clinically important brain injuries is CT imaging of the head. [2003]

For safety, logistic and resource reasons, do not perform magnetic resonance imaging (MRI) scanning as the primary investigation for clinically important brain injury in patients who have sustained a head injury, although it is recognised that additional information of importance to the patient's prognosis can sometimes be detected using MRI. [2003]

Ensure that there is appropriate equipment for maintaining and monitoring the patient within the MRI environment and that all staff involved are aware of the dangers and necessary precautions for working near an MRI scanner. [2003]

Do not use plain X-rays of the skull to diagnose significant brain injury without prior discussion with a neuroscience unit. However, they are useful as part of the skeletal survey in children presenting with suspected non-accidental injury. [2007]

If CT imaging is unavailable because of equipment failure, patients with GCS 15 may be admitted for observation. Arrangements should be in place for urgent transfer to a centre with CT scanning available should there be a clinical deterioration that indicates immediate CT scanning is necessary. [2007]

In line with good radiation exposure practice, make every effort to minimise radiation dose during imaging of the head and cervical spine, while ensuring that image quality and coverage is sufficient to achieve an adequate diagnostic study. [2003]

Criteria for Performing a CT Head Scan

Adults

For adults who have sustained a head injury and have any of the following risk factors, perform a CT head scan within 1 hour of the risk factor being identified:

GCS less than 13 on initial assessment in the emergency department
GCS less than 15 at 2 hours after the injury on assessment in the emergency department.
Suspected open or depressed skull fracture
Any sign of basal skull fracture (haemotympanum, 'panda' eyes, cerebrospinal fluid leakage from the ear or nose, Battle's sign)
Post-traumatic seizure
Focal neurological deficit
More than 1 episode of vomiting
A provisional written radiology report should be made available within 1 hour of the scan being performed [new 2014]

For adults with any of the following risk factors who have experienced some loss of consciousness or amnesia since the injury, perform a CT head scan within 8 hours of the head injury:

- Age 65 years or older
- Any history of bleeding or clotting disorders
- Dangerous mechanism of injury (a pedestrian or cyclist struck by a motor vehicle, an occupant ejected from a motor vehicle or a fall from a height of greater than 1 metre or 5 stairs)
- More than 30 minutes' retrograde amnesia of events immediately before the head injury
  A provisional written radiology report should be made available within 1 hour of the scan being performed [new 2014]

Children

For children who have sustained a head injury and have any of the following risk factors, perform a CT head scan within 1 hour of the risk factor being identified:

- Suspicion of non-accidental injury
- Post-traumatic seizure but no history of epilepsy
- On initial emergency department assessment, GCS less than 14, or for children under 1 year GCS (paediatric) less than 15
- At 2 hours after the injury, GCS less than 15
- Suspected open or depressed skull fracture or tense fontanelle
- Any sign of basal skull fracture (haemotympanum, 'panda' eyes, cerebrospinal fluid leakage from the ear or nose, Battle's sign)
- Focal neurological deficit
- For children under 1 year, presence of bruise, swelling or laceration of more than 5 cm on the head
- A provisional written radiology report should be made available within 1 hour of the scan being performed. [new 2014]

For children who have sustained a head injury and have more than 1 of the following risk factors (and none of those in recommendation above), perform a CT head scan within 1 hour of the risk factors being identified:

- Loss of consciousness lasting more than 5 minutes (witnessed)
- Abnormal drowsiness
- Three or more discrete episodes of vomiting
- Dangerous mechanism of injury (high-speed road traffic accident either as pedestrian, cyclist or vehicle occupant, fall from a height of greater than 3 metres, high-speed injury from a projectile or other object)
- Amnesia (antegrade or retrograde) lasting more than 5 minutes[1]
  A provisional written radiology report should be made available within 1 hour of the scan being performed. [new 2014]

Children who have sustained a head injury and have only 1 of the risk factors in recommendation directly above (and none of the first set of children's risk factors) should be observed for a minimum of 4 hours after the head injury. If during observation any of the risk factors below are identified, perform a CT head scan within 1 hour:

- GCS less than 15
- Further vomiting
- A further episode of abnormal drowsiness
  A provisional written radiology report should be made available within 1 hour of the scan being performed. If none of these risk factors occur during observation, use clinical judgement to determine whether a longer period of observation is needed. [new 2014]

Patients Having Warfarin Treatment

For patients (adults and children) who have sustained a head injury with no other indications for a CT head scan and who are having warfarin treatment, perform a CT head scan within 8 hours of the injury. A provisional written radiology report should be made available within 1 hour of the scan being performed. [new 2014]

Investigating Injuries to the Cervical Spine

Be aware that, as a minimum, CT should cover any areas of concern or uncertainty on X-ray or clinical grounds. [2003]

Ensure that facilities are available for multiplanar reformatting and interactive viewing of CT cervical spine scans. [2003, amended 2014]

Magnetic resonance imaging (MRI) is indicated if there are neurological signs and symptoms referable to the cervical spine. If there is suspicion of vascular injury (for example, vertebral malalignment, a fracture involving the foramina transversaria or lateral processes, or a posterior circulation syndrome), CT or MRI angiography of the neck vessels may be performed to evaluate for this. [2003, amended 2014]

Be aware that MRI may add important information about soft tissue injuries associated with bony injuries demonstrated by X-ray and/or CT. [2003]

MRI has a role in the assessment of ligamentous and disc injuries suggested by X-ray, CT or clinical findings. [2003]

In CT, routinely review on 'bone windows' the occipital condyle region for patients who have sustained a head injury. Reconstruction of standard head images onto a high-resolution bony algorithm is readily achieved with modern CT scanners. [2003]

In patients who have sustained high-energy trauma or are showing signs of lower cranial nerve palsy, pay particular attention to the region of the

foramen magnum. If necessary, perform additional high-resolution imaging for coronal and sagittal reformatting while the patient is on the scanner table. [2003]

Criteria for Performing a CT Cervical Spine Scan in Adults

For adults who have sustained a head injury and have any of the following risk factors, perform a CT cervical spine scan within 1 hour of the risk factor being identified:

- GCS less than 13 on initial assessment
- The patient has been intubated.
- Plain X-rays are technically inadequate (for example, the desired view is unavailable).
- Plain X-rays are suspicious or definitely abnormal.
- A definitive diagnosis of cervical spine injury is needed urgently (for example, before surgery).
- The patient is having other body areas scanned for head injury or multi-region trauma.
- The patient is alert and stable, there is clinical suspicion of cervical spine injury and any of the following apply:
    - Age 65 years or older
    - Dangerous mechanism of injury (fall from a height of greater than 1 metre or 5 stairs; axial load to the head, for example, diving; high-speed motor vehicle collision; rollover motor accident; ejection from a motor vehicle; accident involving motorised recreational vehicles; bicycle collision)
    - Focal peripheral neurological deficit
    - Paraesthesia in the upper or lower limbs

  A provisional written radiology report should be made available within 1 hour of the scan being performed. [new 2014]

For adults who have sustained a head injury and have neck pain or tenderness but no indications for a CT cervical spine scan, perform 3-view cervical spine X-rays within 1 hour if either of these risk factors are identified:

- It is not considered safe to assess the range of movement in the neck.
- Safe assessment of range of neck movement shows that the patient cannot actively rotate their neck to 45 degrees to the left and right.

  The X-rays should be reviewed by a clinician trained in their interpretation within 1 hour of being performed. [new 2014]

Assessing Range of Movement in the Neck

Be aware that in adults and children who have sustained a head injury and in whom there is clinical suspicion of cervical spine injury, range of movement in the neck can be assessed safely before imaging only if no high-risk factors (see recommendations above and below) and at least 1 of the following low-risk features apply. The patient:

- Was involved in a simple rear-end motor vehicle collision
- Is comfortable in a sitting position in the emergency department
- Has been ambulatory at any time since injury
- Has no midline cervical spine tenderness
- Presents with delayed onset of neck pain [new 2014]

Criteria for Performing a CT Cervical Spine Scan in Children

For children who have sustained a head injury, perform a CT cervical spine scan only if any of the following apply (because of the increased risk to the thyroid gland from ionising radiation and the generally lower risk of significant spinal injury):

- GCS less than 13 on initial assessment
- The patient has been intubated
- Focal peripheral neurological signs
- Paraesthesia in the upper or lower limbs
- A definitive diagnosis of cervical spine injury is needed urgently (for example, before surgery).
- The patient is having other body areas scanned for head injury or multi-region trauma.
- There is strong clinical suspicion of injury despite normal X-rays.
- Plain X-rays are technically difficult or inadequate.
- Plain X-rays identify a significant bony injury.

  The scan should be performed within 1 hour of the risk factor being identified. A provisional written radiology report should be made available within 1 hour of the scan being performed. [new 2014]

For children who have sustained a head injury and have neck pain or tenderness but no indications for a CT cervical spine scan, perform 3-view cervical spine X-rays before assessing range of movement in the neck if either of these risk factors are identified:

- Dangerous mechanism of injury (that is, fall from a height of greater than 1 metre or 5 stairs; axial load to the head, for example, diving; high-speed motor vehicle collision; rollover motor accident; ejection from a motor vehicle; accident involving motorised recreational vehicles; bicycle collision)
- Safe assessment of range of movement in the neck is not possible.
  The X-rays should be carried out within 1 hour of the risk factor being identified and reviewed by a clinician trained in their interpretation within 1 hour of being performed. [new 2014]

If range of neck movement can be assessed safely in a child who has sustained a head injury and has neck pain or tenderness but no indications for a CT cervical spine scan, perform 3-view cervical spine X-rays if the child cannot actively rotate their neck 45 degrees to the left and right. The X-rays should be carried out within 1 hour of this being identified and reviewed by a clinician trained in their interpretation within 1 hour of being performed. [new 2014]

In children who can obey commands and open their mouths, attempt an odontoid peg view. [2003, amended 2014]

Information and Support for Families and Carers

Staff caring for patients with a head injury should introduce themselves to family members or carers and briefly explain what they are doing. [2003, amended 2014]

Ensure that information sheets detailing the nature of head injury and any investigations likely to be used are made available in the emergency department. NICE's information for the public about this guideline may be helpful. [2003]

Staff should consider how best to share information with children and introduce them to the possibility of long-term complex changes in their parent or sibling. Literature produced by patient support groups may be helpful. [2003]

Encourage family members and carers to talk and make physical contact (for example, holding hands) with the patient. However, it is important that relatives and friends do not feel obliged to spend long periods at the bedside. If they wish to stay with the patient, encourage them to take regular breaks. [2003, amended 2007]

Ensure there is a board or area displaying leaflets or contact details for patient support organisations either locally or nationally to enable family members and carers to gather further information. [2003]

Transfer from Hospital to a Neuroscience Unit

Transfer of Adults

Local guidelines on the transfer of patients with head injuries should be drawn up between the referring hospital trusts, the neuroscience unit and the local ambulance service, and should recognise that:

- Transfer would benefit all patients with serious head injuries (GCS 8 or less) irrespective of the need for neurosurgery.
- If transfer of those who do not require neurosurgery is not possible, ongoing liaison with the neuroscience unit over clinical management is essential. [2003, amended 2007]

The possibility of occult extracranial injuries should be considered for adults with multiple injuries, and they should not be transferred to a service that is unable to deal with other aspects of trauma. [2007]

There should be a designated consultant in the referring hospital with responsibility for establishing arrangements for the transfer of patients with head injuries to a neuroscience unit and another consultant at the neuroscience unit with responsibility for establishing arrangements for communication with referring hospitals and for receipt of patients transferred. [2003]

Patients with head injuries requiring emergency transfer to a neuroscience unit should be accompanied by a doctor with appropriate training and experience in the transfer of patients with acute brain injury. They should be familiar with the pathophysiology of head injury, the drugs and equipment they will use and working in the confines of an ambulance (or helicopter if appropriate). They should have a dedicated and adequately trained assistant. They should be provided with appropriate clothing for the transfer, medical indemnity and personal accident insurance. Patients requiring non-emergency transfer should be accompanied by appropriate clinical staff. [2003, amended 2007]

Provide the transfer team responsible for transferring a patient with a head injury with a means of communicating changes in the patient's status with

their base hospital and the neurosurgical unit during the transfer. [2003, amended 2014]

Although it is understood that transfer is often urgent, complete the initial resuscitation and stabilisation of the patient and establish comprehensive monitoring before transfer to avoid complications during the journey. Do not transport a patient with persistent hypotension, despite resuscitation, until the cause of the hypotension has been identified and the patient stabilised. [2003, amended 2007]

Intubate and ventilate all patients with GCS 8 or less requiring transfer to a neuroscience unit, and any patients with the indications detailed in recommendation below. [2003]

Intubate and ventilate the patient immediately in the following circumstances:

- Coma – not obeying commands, not speaking, not eye opening (that is, GCS 8 or less)
- Loss of protective laryngeal reflexes
- Ventilatory insufficiency as judged by blood gases: hypoxaemia (partial pressure of oxygen in arterial blood [PaO_2] <13 kPa on oxygen) or hypercarbia (partial pressure of carbon dioxide in arterial blood [$PaCO_2$] >6 kPa)
- Spontaneous hyperventilation causing $PaCO_2$ <4 kPa
- Irregular respirations [2003, amended 2007]

Use intubation and ventilation before the start of the journey in the following circumstances:

- Significantly deteriorating conscious level (1 or more points on the motor score), even if not coma
- Unstable fractures of the facial skeleton
- Copious bleeding into mouth (for example, from skull base fracture)
- Seizures [2003, amended 2007]

Ventilate an intubated patient with muscle relaxation and appropriate short-acting sedation and analgesia. Aim for a PaO_2 >13 kPa, $PaCO_2$ 4.5 to 5.0 kPa unless there is clinical or radiological evidence of raised intracranial pressure, in which case more aggressive hyperventilation is justified. If hyperventilation is used, increase the inspired oxygen concentration. Maintain the mean arterial pressure at 80 mm Hg or more by infusion of fluid and vasopressors as indicated. In children, maintain blood pressure at a level appropriate for the child's age. [2003, amended 2007]

Education, training and audit are crucial to improving standards of transfer; appropriate time and funding for these activities should be provided. [2003]

Give family members and carers as much access to the patient as is practical during transfer. If possible, give them an opportunity to discuss the reasons for transfer and how the transfer process works with a member of the healthcare team. [2003, amended 2014]

Transfer of Children

The recommendations above were written for adults, but apply these principles apply equally to children and infants, providing that the paediatric modification of the GCS is used. [2003]

Service provision in the area of paediatric transfer to tertiary care should also follow the principles outlined in the National Service Framework for Paediatric Intensive Care. These do not conflict with the principles outlined in this section. [2003]

The possibility of occult extracranial injuries should be considered for children with multiple injuries. Do not transfer them to a service that is unable to deal with other aspects of trauma. [2007]

Transfer of a child or infant to a specialist neurosurgical unit should be undertaken by staff experienced in the transfer of critically ill children. [2003]

Give family members and carers as much access to their child as is practical during transfer. If possible, give them an opportunity to discuss the reasons for transfer and how the transfer process works with a member of the healthcare team. [2003, amended 2014]

Admission and Observation

Use the criteria below for admitting patients to hospital following a head injury:

- Patients with new, clinically significant abnormalities on imaging
- Patients whose GCS has not returned to 15 after imaging, regardless of the imaging results
- When a patient has indications for CT scanning but this cannot be done within the appropriate period, either because CT is not available or

because the patient is not sufficiently cooperative to allow scanning
- Continuing worrying signs (for example, persistent vomiting, severe headaches) of concern to the clinician
- Other sources of concern to the clinician (for example, drug or alcohol intoxication, other injuries, shock, suspected non-accidental injury, meningism, cerebrospinal fluid leak) [2003]

Be aware that some patients may require an extended period in a recovery setting because of the use of general anaesthesia during CT imaging. [2003, amended 2007]

Admit patients with multiple injuries under the care of the team that is trained to deal with their most severe and urgent problem. [2003]

In circumstances where a patient with a head injury requires hospital admission, admit the patient only under the care of a team led by a consultant who has been trained in the management of this condition during their higher specialist training. The consultant and their team should have competence (defined by local agreement with the neuroscience unit) in assessment, observation and indications for imaging; inpatient management; indications for transfer to a neuroscience unit (see "Transfer From Hospital to a Neuroscience Unit," above); and hospital discharge and follow-up (see "Discharge and Follow-up," below). [2003, amended 2007]

Observation of Admitted Patients

In-hospital observation of patients with a head injury should only be conducted by professionals competent in the assessment of head injury. [2003]

For patients admitted for head injury observation the minimum acceptable documented neurological observations are: GCS; pupil size and reactivity; limb movements; respiratory rate; heart rate; blood pressure; temperature; blood oxygen saturation. [2003]

Perform and record observations on a half-hourly basis until GCS equal to 15 has been achieved. The minimum frequency of observations for patients with GCS equal to 15 should be as follows, starting after the initial assessment in the emergency department:

- Half-hourly for 2 hours
- Then 1-hourly for 4 hours
- Then 2-hourly thereafter [2003]

Should the patient with GCS equal to 15 deteriorate at any time after the initial 2-hour period, observations should revert to half-hourly and follow the original frequency schedule. [2003]

Any of the following examples of neurological deterioration should prompt urgent reappraisal by the supervising doctor:

- Development of agitation or abnormal behaviour
- A sustained (that is, for at least 30 minutes) drop of 1 point in GCS score (greater weight should be given to a drop of 1 point in the motor response score of the GCS)
- Any drop of 3 or more points in the eye-opening or verbal response scores of the GCS, or 2 or more points in the motor response score
- Development of severe or increasing headache or persisting vomiting
- New or evolving neurological symptoms or signs such as pupil inequality or asymmetry of limb or facial movement [2003, amended 2007]

To reduce inter-observer variability and unnecessary referrals, a second member of staff competent to perform observation should confirm deterioration before involving the supervising doctor. This confirmation should be carried out immediately. Where a confirmation cannot be performed immediately (for example, no staff member available to perform the second observation) the supervising doctor should be contacted without the confirmation being performed. [2003]

If any of the changes noted in the recommendation above are confirmed, an immediate CT scan should be considered, and the patient's clinical condition re-assessed and managed appropriately. [2003, amended 2007]

In the case of a patient who has had a normal CT scan but who has not achieved GCS equal to 15 after 24 hours' observation, a further CT scan or MRI scanning should be considered and discussed with the radiology department. [2003]

Observation of Infants and Young Children

Observation of infants and young children (that is, aged under 5 years) is a difficult exercise and therefore should only be performed by units with staff experienced in the observation of infants and young children with a head injury. Infants and young children may be observed in normal paediatric observation settings, as long as staff have the appropriate experience. [2003]

Training in Observation

Medical, nursing and other staff caring for patients with head injury admitted for observation should all be capable of performing the observations listed in recommendations above. [2003]

The acquisition and maintenance of observation and recording skills require dedicated training and this should be made available to all relevant staff. [2003]

Specific training is required for the observation of infants and young children. [2003]

Discharge and Follow-up

If CT is not indicated on the basis of history and examination the clinician may conclude that the risk of clinically important brain injury to the patient is low enough to warrant transfer to the community, as long as no other factors that would warrant a hospital admission are present (for example, drug or alcohol intoxication, other injuries, shock, suspected non-accidental injury, meningism, cerebrospinal fluid leak) and there are appropriate support structures for safe transfer to the community and for subsequent care (for example, competent supervision at home). [2003]

After normal imaging of the head, the clinician may conclude that the risk of clinically important brain injury requiring hospital care is low enough to warrant transfer to the community, as long as the patient has returned to GCS equal to 15, and no other factors that would warrant a hospital admission are present (for example, drug or alcohol intoxication, other injuries, shock, suspected non-accidental injury, meningism, cerebrospinal fluid leak) and there are appropriate support structures for safe transfer to the community and for subsequent care (for example, competent supervision at home). [2003]

After normal imaging of the cervical spine the clinician may conclude that the risk of injury to the cervical spine is low enough to warrant transfer to the community, as long as the patient has returned to GCS equal to 15 and their clinical examination is normal, and no other factors that would warrant a hospital admission are present (for example, drug or alcohol intoxication, other injuries, shock, suspected non-accidental injury, meningism, cerebrospinal fluid leak) and there are appropriate support structures for safe transfer to the community and for subsequent care (for example, competent supervision at home). [2003]

Do not discharge patients presenting with head injury until they have achieved GCS equal to 15, or normal consciousness in infants and young children as assessed by the paediatric version of the GCS. [2003]

All patients with any degree of head injury should only be transferred to their home if it is certain that there is somebody suitable at home to supervise the patient. Discharge patients with no carer at home only if suitable supervision arrangements have been organised, or when the risk of late complications is deemed negligible. [2003]

Discharge After Observation

Patients admitted after a head injury may be discharged after resolution of all significant symptoms and signs providing they have suitable supervision arrangements at home. [2003]

Discharge Advice

Give verbal and printed discharge advice to patients with any degree of head injury who are discharged from an emergency department or observation ward, and their families and carers. Follow recommendations in the NICE guideline Patient experience in adult NHS services (NICE clinical guideline 138) about providing information in an accessible format. [new 2014]

Printed advice for patients, families and carers should be age-appropriate and include:

- Details of the nature and severity of the injury
- Risk factors that mean patients need to return to the emergency department
- A specification that a responsible adult should stay with the patient for the first 24 hours after their injury
- Details about the recovery process, including the fact that some patients may appear to make a quick recovery but later experience difficulties or complications
- Contact details of community and hospital services in case of delayed complications
- Information about return to everyday activities, including school, work, sports and driving
- Details of support organisations [new 2014]

Offer information and advice on alcohol or drug misuse to patients who presented to the emergency department with drug or alcohol intoxication when they are fit for discharge. [2003]

Inform patients and their families and carers about the possibility of persistent or delayed symptoms following head injury and whom to contact if they experience ongoing problems. [new 2014]

For all patients who have attended the emergency department with a head injury, write to their GP within 48 hours of discharge, giving details of clinical history and examination. This letter should also be shared with health visitors (for pre-school children) and school nurses (for school-age children). If appropriate, provide a copy of the letter for the patient and their family or carer. [new 2014]

Follow-up

When a patient who has undergone imaging of the head and/or been admitted to hospital experiences persisting problems, ensure that there is an opportunity available for referral from primary care to an outpatient appointment with a professional trained in assessment and management of sequelae of brain injury (for example, clinical psychologist, neurologist, neurosurgeon, specialist in rehabilitation medicine). [2003]

Clinical Algorithm(s)

The following algorithms are provided in the full version of the original guideline document:

- Selection of adults for CT head scan
- Selection of children for CT head scan
- Selection of adults for imaging of the cervical spine
- Selection of children for imaging of the cervical spine

In addition, a NICE pathway on head injury is available from the National Institute for Health and Care Excellence (NICE) Web site .

Scope

Disease/Condition(s)

Head injury (head trauma), including brain or cervical spine injury

Note: For the purposes of this guideline, head injury is defined as any trauma to the head, other than superficial injuries to the face.

Guideline Category

Diagnosis

Evaluation

Management

Risk Assessment

Clinical Specialty

Critical Care

Emergency Medicine

Family Practice

Internal Medicine

Neurological Surgery

Neurology

Nursing

Pediatrics

Radiology

Intended Users

Advanced Practice Nurses

Emergency Medical Technicians/Paramedics

Health Care Providers

Hospitals

Nurses

Patients

Physical Therapists

Physician Assistants

Physicians

Psychologists/Non-physician Behavioral Health Clinicians

Guideline Objective(s)

To offer best practice advice on the care of people with head injury

Target Population

All patients who presented with a suspected or confirmed traumatic head injury with or without other major trauma

Interventions and Practices Considered

Diagnosis/Evaluation

1. Assessment in the emergency department
    - Stabilisation of airway, breathing and circulation
    - Assessment within 15 minutes
    - Establishing the need for computed tomography (CT)
    - Pain management
2. Involvement of neurosurgical specialists
3. CT of the head
4. Magnetic resonance imaging (MRI)
5. X-rays
6. Observation
7. Assessment of range of motion

Management

1. Pre-hospital assessment and referral
    - Telephone advice services (for example, National Health Service [NHS] 111 or emergency department helplines)
    - Community health services and minor injury clinics

2. Transport to hospital
3. Immediate management at scene
    - Use of the Glasgow Coma Scale
    - Initial assessment and care of adults using Advanced Trauma Life Support (ATLS) course/European Trauma course, International Trauma Life Support (ITLS) course, Pre-hospital Trauma Life Support (PHTLS) course, Advanced Trauma Nurse Course (ATNC), Trauma Nursing Core Course (TNCC), or Joint Royal Colleges Ambulance Service Liaison Committee (JRCALC) Clinical Practice Guidelines for Head Trauma
    - Initial assessment and management of children using Advanced Paediatric Life Support (APLS)/European Paediatric Life Support (EPLS) course, Pre-hospital Paediatric Life Support (PHPLS) course, Paediatric Education for Pre-hospital Professionals (PEPP) course
    - Cervical immobilisation
4. Support for families and carers
5. Appropriate training in safeguarding
6. Transport to a neuroscience unit
7. Observation
8. Discharge and follow-up

Major Outcomes Considered

- Clinically important brain or cervical spine injury (primary patient outcome)
- Intracranial bleeding
- Sensitivity and specificity of the imaging technique or clinical rules/diagnostic accuracy
- Neurological outcome
- Disability
- Hospital stay duration
- Mortality
- Morbidity
- Cost-effectiveness

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance.

Developing the Review Questions and Outcomes

Review questions were developed in a framework of population, index tests, reference standard and target condition for reviews of diagnostic test accuracy; and using population, presence or absence of factors under investigation (for example prognostic factors) and outcomes for prognostic reviews. This was to guide the literature searching process, critical appraisal and synthesis of evidence, and facilitated the development of recommendations by the Guideline Development Group (GDG). The review questions were drafted by the NCGC technical team and refined and validated by the GDG. The questions were based on the key clinical areas identified in the scope (see Appendix C in the full version of the original guideline document).

A total of 10 review questions were identified. Each question includes adults, children and infants, these groups were analysed separately (stratified by population age).

Full literature searches, critical appraisals and evidence reviews were completed for all the specified review questions.

Searching for Evidence

Clinical Literature Search

Systematic literature searches were undertaken to identify evidence within published literature in order to answer the review questions as per The Guidelines Manual (2009). Clinical databases were searched using relevant medical subject headings, free-text terms and study type filters where appropriate. Studies published in languages other than English were not reviewed. Where possible, searches were restricted to articles published in English language. All searches were conducted on core databases, MEDLINE, EMBASE and The Cochrane Library. Cumulative Index to Nursing and Allied Health Literature (CINAHL) was also searched for patient views. All searches were updated on 31 May 2013. No papers after this date were considered.

Search strategies were checked by looking at reference lists of relevant key papers, checking search strategies in other systematic reviews and asking the GDG for known studies. The questions, the study types applied, the databases searched and the years covered can be found in Appendix G in the full version of the guideline document.

During the scoping stage, a search was conducted for guidelines and reports on the websites listed below and on organisations relevant to the topic. Searching for other grey literature or unpublished literature was not undertaken. All references sent by stakeholders were considered.

- Guidelines International Network database (www.g-i-n.net)
- National Guideline Clearinghouse (www.guideline.gov)
- National Institute for Health and Care Excellence (NICE) (www.nice.org.uk)
- National Institutes of Health Consensus Development Program (consensus.nih.gov)
- NHS Evidence (www.evidence.nhs.uk)
- New Zealand Guideline Group (NZGG) (www.nzgg.org.nz)
- American College of Radiology appropriateness criteria (http://www.acr.org/quality-safety/appropriateness-criteria)

Health Economic Literature Search

Systematic literature searches were also undertaken to identify health economic evidence within published literature relevant to the review questions. The evidence was identified by conducting a broad search relating to head injury in the NHS economic evaluation database (NHS EED), the Health Economic Evaluations Database (HEED) and health technology assessment (HTA) databases with no date restrictions. Additionally, the search was run on MEDLINE and EMBASE, with a specific economic filter, from 2010, to ensure recent publications that had not yet been indexed by these databases were identified. This was supplemented by additional searches in MEDLINE and EMBASE that looked for papers specifically relating to quality of life in two patient groups, patients with head injury on anticoagulants and patients with cervical spine injury. Studies published in languages other than English were not reviewed. Where possible, searches were restricted to articles published in English language.

The search strategies for health economics are included in Appendix G in the full version of the guideline document. The economic search was updated on 31 May 2013, the quality of life search updated March 18, 2013. No papers published after these dates were considered.

Evidence of Effectiveness

The Research Fellow:

- Identified potentially relevant studies for each review question from the relevant search, results by reviewing titles and abstracts – full papers were then obtained.
- Reviewed full papers against pre-specified inclusion/exclusion criteria to identify studies that addressed the review question in the appropriate population and reported on outcomes of interest (review protocols are included in Appendix D in the full version of the guideline document).

Inclusion/Exclusion

The inclusion/exclusion of studies was based on the review protocols (see Appendix D in the full version of the original guideline document). The

GDG were consulted about any uncertainty regarding inclusion/exclusion.

Conference abstracts were not automatically excluded from the review but were initially assessed against the inclusion criteria and then further processed only if no other full publication was available for that review question, in which case the authors of the selected abstracts were contacted for further information. Only one review included abstracts; clinical decision rules for the selection of children for head computed tomography (CT) scan.

Literature reviews, letters and editorials, foreign language publications and unpublished studies were excluded.

Evidence of Cost-Effectiveness

Evidence on cost effectiveness related to the key clinical issues being addressed in the guideline was sought. The health economist undertook:

- A systematic review of the published economic literature
- New cost-effectiveness analysis in priority areas

Literature Review

The Health Economist:

- Identified potentially relevant studies for each review question from the economic search results by reviewing titles and abstracts – full papers were then obtained.
- Reviewed full papers against pre-specified inclusion/exclusion criteria to identify relevant studies (see the full version of the original guideline document for details).

Inclusion/Exclusion

Full economic evaluations (studies comparing costs and health consequences of alternative courses of action: cost-utility, cost-effectiveness, cost-benefit and cost-consequence analyses) and comparative costing studies that addressed the review question in the relevant population were considered potentially includable as economic evidence.

Studies that only reported cost per hospital (not per patient), or only reported average cost effectiveness without disaggregated costs and effects, were excluded. Abstracts, posters, reviews, letters/editorials, foreign language publications and unpublished studies were excluded. Studies judged to have an applicability rating of 'not applicable' were excluded (this included studies that took the perspective of a country outside the Organisation for Economic Co-operation and Development [OECD]).

Remaining studies were prioritised for inclusion based on their relative applicability to the development of this guideline and study limitations. For example, if a high quality, directly applicable United Kingdom (UK) analysis was available other less relevant studies may not have been included. Where exclusions occurred on this basis, this is noted in the relevant section.

For more details about the assessment of applicability and methodological quality see the economic evaluation checklist (The Guidelines Manual, 2009 and the health economics research protocol in Appendix D in the full version of the original guideline document; see the "Availability of Companion Documents" field).

Number of Source Documents

Not stated

Methods Used to Assess the Quality and Strength of the Evidence

Expert Consensus

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Overall Quality of Outcome Evidence in Grading of Recommendations Assessment, Development and Evaluation (GRADE)

Level	Description
High	Further research is very unlikely to change confidence in the estimate of effect.
Moderate	Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate.
Low	Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate.
Very Low	Any estimate of effect is very uncertain.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance.

Evidence of Effectiveness

The Research Fellow:

- Critically appraised relevant studies using the appropriate checklist as specified in The Guidelines Manual (see the "Availability of Companion Documents" field).
- Extracted key information about the study's methods and placed results into evidence tables (evidence tables are included in Appendix H in the full version of the original guideline document).
- Generated summaries of the evidence by outcome (included in the relevant chapter write-ups), which were presented in Guideline Development Group (GDG) meetings:
    - Observational studies: data presented as a range of values in Grading of Recommendations Assessment, Development, and Evaluation (GRADE) profiles.
    - Diagnostic studies: data presented as a range of values in adapted GRADE profiles (diagnostic test accuracy: sensitivity, specificity, positive and negative predictive value). Meta-analyses could not be conducted because the studies reported data at various thresholds or there was insufficient data to pool.
    - Prognostic studies: data were presented as a range of values, usually in terms of the relative effect as reported by the authors.
    - Qualitative studies: each study was summarised in a table where possible, otherwise information was presented in a narrative.

Methods of Combining Clinical Studies

Data Synthesis for Prognostic Factor Reviews

Odds ratios, relative risks or hazard ratios, with their 95% confidence intervals, from multivariate analyses were extracted from the papers, and standard errors were calculated from the 95% confidence intervals. The log of the effect size with its standard error was entered into the generic inverse variance technique in the Cochrane Review Manager (RevMan5) software. Studies were not combined in a meta-analysis for observational studies. Sensitivity analyses were carried out on the basis of study quality and results were reported as ranges.

Data Synthesis for Diagnostic Test Accuracy Review

For diagnostic test accuracy studies (including head computed tomography [CT] and cervical spine imaging clinical decision rules), the following measures of diagnostic accuracy were reported: sensitivity, specificity, positive predictive value, negative predictive value. In cases where the outcomes were not reported, 2 by 2 tables were constructed from raw data to allow calculation of these accuracy measures. As only two outcomes were prioritised for inclusion (diagnostic accuracy of need for neurosurgical intervention and diagnostic accuracy of any intracranial abnormality), both were considered to be critical outcomes. Clinical evidence profiles give diagnostic accuracy data as ranges of 95% confidence intervals.

Diagnostic test accuracy measures used in the analysis were sensitivity and specificity, positive and negative predictive value. The threshold of a diagnostic test is defined as the value at which the test can best differentiate between those with and without the target condition and, in practice, it varies amongst studies. The GDG discussed the clinically relevant thresholds for biomarker tests and accepted the manufacturer's instructions. All the clinically relevant thresholds can be found in the evidence review.

Coupled forest plots of sensitivity and specificity with their 95% confidence intervals across studies were produced for each test, using Cochrane Review Manager (RevMan5) software. In order to do that, 2 by 2 tables (the number of true positives, false positives, true negatives and false negatives) were either directly taken from the study if given or derived from raw data, or were calculated from the set of test accuracy statistics.

Heterogeneity or inconsistency amongst studies was visually inspected in the forest plots, if appropriate (only when there were similar thresholds). A diagnostic meta-analysis was not conducted mainly because of the low quality of the studies. Metaâ€analysis of studies at risk of bias may be misleading as metaâ€analysis may compound the errors and produce an inaccurate result which may be misinterpreted as having reliability. Differences in thresholds across studies and in patient selection criteria may also impact on test accuracy and therefore are additional reasons why meta-analysis was not conducted.

Data Synthesis for Qualitative Reviews

Themes were identified from these studies and were supplemented with data from surveys where available. Identification of themes was based on what the studies reported, no additional interpretation was conducted in order to minimise bias. Common themes relevant to the question are reported in a narrative in the guideline text.

The evidence for outcomes from the included studies were evaluated and presented using an adaptation of the "GRADE toolbox" developed by the international GRADE working group (http://www.gradeworkinggroup.org/). The software (GRADEpro) developed by the GRADE working group was used to assess the quality of each outcome, taking into account individual study quality and meta-analysis results. The summary of findings was presented as two separate tables in the full version of the original guideline document. Reporting or publication bias was only taken into consideration in the quality assessment and included in the "Clinical Study Characteristics" table in the full version of the guideline document if it was apparent.

Each outcome was examined separately for the quality elements listed and defined in Table 2 in the full version of the original guideline document and each graded using the quality levels listed in Table 3 in the full version of the original guideline document. The main criteria considered in the rating of these elements are discussed below (see Section 3.4.3 "Grading the quality of evidence" in the full version of the original guideline document). Footnotes were used to describe reasons for grading a quality element as having serious or very serious problems. The ratings for each component were summed to obtain an overall assessment for each outcome in Table 4 in the full version of the original guideline document. The GRADE toolbox is currently designed only for randomised trials and observational studies but we adapted the quality assessment elements and outcome presentation for diagnostic accuracy studies.

Grading the Quality of Clinical Evidence

The overall quality of evidence for each outcome was considered. The following procedure was adopted when using Grading of Recommendations Assessment, Development and Evaluation (GRADE):

1. A quality rating was assigned, based on the study design. Randomised controlled trials (RCTs), prospective diagnostic cross sectional or cohort studies start HIGH and observational studies as LOW, uncontrolled case series as LOW or VERY LOW.
2. The rating was then downgraded or upgraded for the specified criteria: Study limitations, inconsistency, indirectness, imprecision and reporting bias. These criteria are detailed below. Observational studies were upgraded if there was: a large magnitude of effect, dose-response gradient, and if all plausible confounding would reduce a demonstrated effect or suggest a spurious effect when results showed no effect. Each quality element considered to have "serious" or "very serious" risk of bias were rated down -1 or -2 points respectively.
3. The downgraded/upgraded marks were then summed and the overall quality rating was revised. For example, all RCTs started as HIGH and the overall quality became MODERATE, LOW or VERY LOW if 1, 2 or 3 points were deducted respectively.
4. The reasons or criteria used for downgrading were specified in the footnotes.

Study Limitations

For diagnostic accuracy studies, the Quality Assessment of Diagnostic Accuracy Studies version 2 (QUADAS-2) checklists were used. Risk of bias and applicability in primary diagnostic accuracy studies in QUADAS-2 consists of 4 domains (see Figure 1 in the full version of the original guideline document).

Additional information related to factors that affect quality such as study limitations, inconsistency, indirectness, and imprecision are detailed in

section 3.4 in the full version of the original guideline document.

Evidence of Cost-Effectiveness

Literature Review

The Health Economist:

- Critically appraised relevant studies using the economic evaluations checklist as specified in The Guidelines Manual (see the "Availability of Companion Documents" field).
- Extracted key information about the studies' methods and results into evidence tables (see Appendix I in the full version of the original guideline document).
- Generated summaries of the evidence in NICE economic evidence profiles (included in the relevant chapter write-ups).

NICE Economic Evidence Profiles

The NICE economic evidence profile has been used to summarise cost and cost-effectiveness estimates. The economic evidence profile shows, for each economic study, an assessment of applicability and methodological quality, with footnotes indicating the reasons for the assessment. These assessments were made by the health economist using the economic evaluation checklist from The Guidelines Manual. It also shows incremental costs, incremental effects (for example, quality-adjusted life years [QALYs]) and the incremental cost-effectiveness ratio, as well as information about the assessment of uncertainty in the analysis. See Table 5 in the full version of the original guideline document for more details.

Undertaking New Health Economic Analysis

As well as reviewing the published economic literature for each review question, as described above, new economic analysis can be undertaken by the health economist in selected areas and where there is sufficient evidence to populate the analysis. Priority areas for new health economic analysis were agreed by the GDG after formation of the review questions and consideration of the available health economic evidence.

The GDG identified diagnostic strategies for ruling out cervical spinal injury in patients with head injury as the highest priority area for original economic modelling. The main trade offs for this topic are represented by the cost of diagnostic tests (whether X-ray, computed tomography [CT] scan and magnetic resonance [MR] imaging) versus the failure to detect a cervical spine injury (false negatives) which could lead to a delay in appropriate management, high adverse health consequences and associated health resource use. Appropriate selection of patients to undergo diagnostic imaging, and further imaging in the case of indeterminate or negative initial imaging results, is key in ensuring the optimal balance of maximising health gain and National Health Service (NHS) resource use. However, there is a limited economic evidence base to clarify these trade offs and quantify expected outcomes of different decision rules which could be used in this context. As a consequence, the GDG identified this topic as a high priority for an original economic analysis.

The following general principles were adhered to in developing the cost-effectiveness analysis:

- Methods were consistent with the NICE reference case.
- The GDG was involved in the design of the model, selection of inputs and interpretation of the results.
- Model inputs were based on the systematic review of the clinical literature supplemented with other published data sources where possible.
- When published data was not available GDG expert opinion was used to populate the model.
- Model inputs and assumptions were reported fully and transparently.
- The results were subject to sensitivity analysis and limitations were discussed.
- The model was peer-reviewed by another health economist at the National Clinical Guideline Centre (NCGC).

Full methods for the cost-effectiveness analysis for cervical spine injury clearance strategies are described in Appendix M in the full version of the original guideline document.

In the Absence of Economic Evidence

When no relevant published studies were found, and a new analysis was not prioritised, the GDG made a qualitative judgement about cost effectiveness by considering expected differences in resource use between options and relevant UK NHS unit costs alongside the results of the clinical effectiveness evidence.

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance.

A multidisciplinary Guideline Development Group (GDG) comprising professional group members and consumer representatives of the main stakeholders developed this guideline. The group met every 4–6 weeks during the development of the guideline.

Developing Recommendations

Over the course of the guideline development process, the GDG was presented with:

- Evidence tables of the clinical and economic evidence reviewed from the literature. All evidence tables are in Appendices H and I in the full version of the guideline document.
- Summary of clinical and economic evidence and quality (as presented in Chapters 6–10 in the full version of the original guideline document)
- Forest plots (see Appendix J in the full version of the original guideline document)
- A description of the methods and results of the cost-effectiveness analysis undertaken for the guideline (see Appendix M in the full version of the original guideline document)

Recommendations were drafted on the basis of the GDG interpretation of the available evidence, taking into account the balance of benefits, harms and costs. When clinical and economic evidence was of poor quality, conflicting or absent, the GDG drafted recommendations based on their expert opinion. The considerations for making consensus based recommendations include the balance between potential harms and benefits, economic or cost implications compared to the benefits, current practices, recommendations made in other relevant guidelines, patient preferences and equality issues. The consensus recommendations were done through discussions in the GDG. The GDG may also consider whether the uncertainty is sufficient to justify delaying making a recommendation to await further research, taking into account the potential harm of failing to make a clear recommendation.

Rating Scheme for the Strength of the Recommendations

Strength of Recommendations

Some recommendations can be made with more certainty than others. The Guideline Development Group (GDG) makes a recommendation based on the trade-off between the benefits and harms of an intervention, taking into account the quality of the underpinning evidence. For some interventions, the GDG is confident that, given the information it has looked at, most patients would choose the intervention. The wording used in the recommendations in this guideline denotes the certainty with which the recommendation is made (the strength of the recommendation).

Interventions That Must (or Must Not) Be Used

The GDG usually uses 'must' or 'must not' only if there is a legal duty to apply the recommendation. Occasionally 'must' (or 'must not') is used if the consequences of not following the recommendation could be extremely serious or potentially life threatening.

Interventions That Should (or Should Not) Be Used – a 'Strong' Recommendation

The GDG uses 'offer' (and similar words such as 'refer' or 'advise') when confident that, for the vast majority of patients, an intervention will do more good than harm, and be cost-effective. Similar forms of words (for example, 'Do not offer…') are used when the GDG is confident that an intervention will not be of benefit for most patients.

Interventions That Could Be Used

The GDG uses 'consider' when confident that an intervention will do more good than harm for most patients, and be cost-effective, but other options may be similarly cost-effective. The choice of intervention, and whether or not to have the intervention at all, is more likely to depend on the patient's values and preferences than for a strong recommendation, and so the healthcare professional should spend more time considering and discussing the options with the patient.

Recommendation Wording in Guideline Updates

NICE began using this approach to denote the strength of recommendations in guidelines that started development after publication of the 2009 version of 'The Guidelines Manual' (January 2009; see the "Availability of Companion Documents" field). This does not apply to any

recommendations ending [2003] or [2007]. In particular, for recommendations labelled [2003] and [2007], the word 'consider' may not necessarily be used to denote the strength of the recommendation.

Cost Analysis

Cost-effectiveness Criteria

The National Institute for Health and Care Excellence (NICE) report 'Social value judgements: principles for the development of NICE guidance' sets out the principles that Guideline Development Groups (GDGs) should consider when judging whether an intervention offers good value for money. In general, an intervention was considered to be cost effective if either of the following criteria applied (given that the estimate was considered plausible):

a. The intervention dominated other relevant strategies (that is, it was both less costly in terms of resource use and more clinically effective compared with all the other relevant alternative strategies), or
b. The intervention cost less than £20,000 per quality-adjusted life year (QALY) gained compared with the next best strategy.

If the GDG recommended an intervention that was estimated to cost more than £20,000 per QALY gained, or did not recommend one that was estimated to cost less than £20,000 per QALY gained, the reasons for this decision are discussed explicitly in the 'Linking evidence to recommendations' section of the relevant chapter in the full version of the original guideline document with reference to issues regarding the plausibility of the estimate or to the factors set out in the 'Social value judgements: principles for the development of NICE guidance'.

When QALYs or life years gained are not used in the analysis, results are difficult to interpret unless one strategy dominates the others with respect to every relevant health outcome and cost. Where evidence, including original economic analysis, reports the cost per effect (i.e., life year gained or false negative avoided) rather than the cost per QALY gained, the limitations in interpreting the results are also explicitly discussed in the 'Linking evidence to recommendations' section of the relevant chapter in the full version of the original guideline document.

Method of Guideline Validation

External Peer Review

Internal Peer Review

Description of Method of Guideline Validation

The guidance is subject to an eight week public consultation and feedback as part of the quality assurance and peer review of the document. All comments received from registered stakeholders are responded to individually and posted on the National Institute for Health and Care Excellence (NICE) website when the pre-publication check of the full guideline occurs.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of evidence supporting the recommendations is not specifically stated.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Appropriate triage, assessment, investigation and early management of head injury in children, young people and adults

Potential Harms

- Radiation risks
- Complications due to transport
- Failure to detect a cervical spine injury (false negatives) which could lead to a delay in appropriate management, high adverse health consequences and associated health resource use
- Significant false positive and false negative rates found in testing

See the "Trade-off between clinical benefits and harms" sections in the full version of the original guideline document for details about harms of specific interventions.

Qualifying Statements

Qualifying Statements

- This guidance represents the view of the National Institute for Health and Care Excellence (NICE), which was arrived at after careful consideration of the evidence available. Healthcare professionals are expected to take it fully into account when exercising their clinical judgement. However, the guidance does not override the responsibility of healthcare professionals to make decisions appropriate to the circumstances of each patient, in consultation with the patient and/or their guardian or carer.
- Implementation of this guidance is the responsibility of local commissioners and/or providers. Commissioners and providers are reminded that it is their responsibility to implement the guidance, in their local context, in light of their duties to have due regard to the need to eliminate unlawful discrimination, advance equality of opportunity and foster good relations. Nothing in this guidance should be interpreted in a way that would be inconsistent with compliance with those duties.
- The guideline will assume that prescribers will use a drug's summary of product characteristics to inform decisions made with individual patients.
- This guideline recommends some drugs for indications for which they do not have a UK marketing authorisation at the date of publication, if there is good evidence to support that use. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. The patient (or those with authority to give consent on their behalf) should provide informed consent, which should be documented. See the General Medical Council's Good practice in prescribing and managing medicines and devices for further information. Where recommendations have been made for the use of drugs outside their licensed indications ('off-label use'), these drugs are marked with a footnote in the recommendations.
- Patients should have the opportunity to make informed decisions about their care and treatment, in partnership with their healthcare professionals. If the patient is under 16, their family or carers should also be given information and support to help the child or young person to make decisions about their treatment. Healthcare professionals should follow the Department of Health's advice on consent (or, in Wales, advice on consent from the Welsh Government). If someone does not have capacity to make decisions, healthcare professionals should follow the code of practice that accompanies the Mental Capacity Act and the supplementary code of practice on deprivation of liberty safeguards.
- NICE has produced guidance on the components of good patient experience in adult NHS services. All healthcare professionals should follow the recommendations in Patient experience in adult NHS services.
- For all recommendations, NICE expects that there is discussion with the patient about the risks and benefits of the interventions, and their values and preferences. This discussion aims to help them to reach a fully informed decision.
- If a young person is moving between paediatric and adult services, care should be planned and managed according to the best practice guidance described in the Department of Health's Transition: getting it right for young people.
- Adult and paediatric healthcare teams should work jointly to provide assessment and services to young people with head injury. Diagnosis and management should be reviewed throughout the transition process, and there should be clarity about who is the lead clinician to ensure continuity of care.

Implementation of the Guideline

Description of Implementation Strategy

The National Institute for Health and Care Excellence (NICE) has developed tools to help organisations implement this guidance. These are available on the NICE website (see also the "Availability of Companion Documents" field).

Key Priorities for Implementation

The following recommendations have been identified as priorities for implementation.

Transport to Hospital

Transport patients who have sustained a head injury directly to a hospital that has the resources to further resuscitate them and to investigate and initially manage multiple injuries. All acute hospitals receiving patients with head injury directly from an incident should have these resources, which should be appropriate for a patient's age. (In the National Health Service [NHS] in England these hospitals would be trauma units or major trauma centres. In the NHS in Wales this should be a hospital with equivalent capabilities.) [new 2014]

Assessment in the Emergency Department

A clinician with training in safeguarding should be involved in the initial assessment of any patient with a head injury presenting to the emergency department. If there are any concerns identified, document these and follow local safeguarding procedures appropriate to the patient's age. [2003, amended 2014]

Criteria for Performing a Computed Tomography (CT) Head Scan

For adults who have sustained a head injury and have any of the following risk factors, perform a CT head scan within 1 hour of the risk factor being identified:

- Glasgow Coma Scale (GCS) less than 13 on initial assessment in the emergency department
- GCS less than 15 at 2 hours after the injury on assessment in the emergency department
- Suspected open or depressed skull fracture
- Any sign of basal skull fracture (haemotympanum, 'panda' eyes, cerebrospinal fluid leakage from the ear or nose, Battle's sign)
- Post-traumatic seizure
- Focal neurological deficit
- More than 1 episode of vomiting
  A provisional written radiology report should be made available within 1 hour of the scan being performed. [new 2014]

For children who have sustained a head injury and have any of the following risk factors, perform a CT head scan within 1 hour of the risk factor being identified:

- Suspicion of non-accidental injury
- Post-traumatic seizure but no history of epilepsy
- On initial emergency department assessment, GCS less than 14, or for children under 1 year GCS (paediatric) less than 15
- At 2 hours after the injury, GCS less than 15
- Suspected open or depressed skull fracture or tense fontanelle
- Any sign of basal skull fracture (haemotympanum, 'panda' eyes, cerebrospinal fluid leakage from the ear or nose, Battle's sign)
- Focal neurological deficit
- For children under 1 year, presence of bruise, swelling or laceration of more than 5 cm on the head
  A provisional written radiology report should be made available within 1 hour of the scan being performed. [new 2014]

For children who have sustained a head injury and have more than one of the following risk factors (and none of those in the recommendation above), perform a CT head scan within 1 hour of the risk factors being identified:

- Loss of consciousness lasting more than 5 minutes (witnessed)
- Abnormal drowsiness
- Three or more discrete episodes of vomiting
- Dangerous mechanism of injury (high-speed road traffic accident either as pedestrian, cyclist or vehicle occupant, fall from a height of greater than 3 metres, high-speed injury from a projectile or other object).
- Amnesia (antegrade or retrograde) lasting more than 5 minutes. (Assessment of amnesia will not be possible in preverbal children and is unlikely to be possible in children aged under 5 years.)
- A provisional written radiology report should be made available within 1 hour of the scan being performed [new 2014]

Children who have sustained a head injury should be observed for a minimum of 4 hours after the head injury. If during observation any of the risk factors below are identified, perform a CT head scan within 1 hour.

- GCS less than 15
- Further vomiting
- A further episode of abnormal drowsiness
  A provisional written radiology report should be made available within 1 hour of the scan being performed. If none of these risk factors occur during observation, use clinical judgement to determine whether a longer period of observation is needed. [new 2014]

For patients (adults and children) who have sustained a head injury with no other indications for a CT head scan and who are having warfarin treatment, perform a CT head scan within 8 hours of the injury. A provisional written radiology report should be made available within 1 hour of the scan being performed. [new 2014]

Investigating Injuries to the Cervical Spine

For adults who have sustained a head injury and have any of the following risk factors, perform a CT cervical spine scan within 1 hour of the risk factor being identified:

- GCS less than 13 on initial assessment
- The patient has been intubated
- Plain X-rays are technically inadequate (for example, the desired view is unavailable).
- Plain X-rays are suspicious or definitely abnormal.
- A definitive diagnosis of cervical spine injury is needed urgently (for example, before surgery).
- The patient is having other body areas scanned for head injury or multi-region trauma.
- The patient is alert and stable, there is clinical suspicion of cervical spine injury and any of the following apply:
  - Age 65 years or older
  - Dangerous mechanism of injury (fall from a height of greater than 1 metre or 5 stairs; axial load to the head, for example, diving; high-speed motor vehicle collision; rollover motor accident; ejection from a motor vehicle; accident involving motorised recreational vehicles; bicycle collision)
  - Focal peripheral neurological deficit
  - Paraesthesia in the upper or lower limbs

  A provisional written radiology report should be made available within 1 hour of the scan being performed [new 2014]

Discharge and Follow-Up

Give verbal and printed discharge advice to patients with any degree of head injury who are discharged from an emergency department or observation ward, and their families and carers. Follow recommendations in the NICE guideline Patient experience in adult NHS services (NICE clinical guideline 138) about providing information in an accessible format. [new 2014]

Printed advice for patients, family members and carers should be age-appropriate and include:

- Details of the nature and severity of the injury
- Risk factors that mean patients need to return to the emergency department
- A specification that a responsible adult should stay with the patient for the first 24 hours after their injury
- Details about the recovery process, including the fact that some patients may appear to make a quick recovery but later experience difficulties or complications
- Contact details of community and hospital services in case of delayed complications
- Information about return to everyday activities, including school, work, sports and driving
- Details of support organisations [new 2014]

Implementation Tools

Audit Criteria/Indicators

Clinical Algorithm

Mobile Device Resources

Patient Resources

Resources

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Patient-centeredness

Timeliness

Identifying Information and Availability

Bibliographic Source(s)

National Clinical Guideline Centre. Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults. London (UK): National Institute for Health and Care Excellence (NICE); 2014 Jan. 63 p. (Clinical guideline; no. 176).

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

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Guideline Developer(s)

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National Institute for Health and Care Excellence (NICE)

Guideline Committee

Guideline Development Group (GDG)

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Financial Disclosures/Conflicts of Interest

At the start of the guideline development process all Guideline Development Group (GDG) members declared interests including consultancies, fee-paid work, share-holdings, fellowships and support from the healthcare industry. At all subsequent GDG meetings, members declared arising conflicts of interest, which were also recorded (see Appendix B in the full version of the original guideline document).

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: National Collaborating Centre for Acute Care. Head injury. Triage, assessment, investigation and early management of head injury in infants, children and adults. London (UK): National Institute for Health and Clinical Excellence (NICE); 2007 Sep. 54 p. (Clinical guideline; no. 56).

Guideline Availability

Electronic copies: Available from the National Institute for Health and Care Excellence (NICE) Web site .

Availability of Companion Documents

The following are available:

- Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults. Full guideline. London (UK): National Institute for Health and Care Excellence; 2014 Jan. 286 p. (Clinical guideline; no. 176). Electronic copies: Available in Portable Document Format (PDF) from the National Institute for Health and Care Excellence (NICE) Web site .
- Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults. Appendices to full guideline. London (UK): National Institute for Health and Care Excellence; 2014 Jan. 618 p. (Clinical guideline; no. 176). Electronic copies: Available in PDF from the NICE Web site .
- Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults. Clinical audit tool. London (UK): National Institute for Health and Care Excellence; 2014 Jan. (Clinical guideline; no. 176). Electronic copies: Available from the NICE Web site .
- Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults. Costing report. London (UK): National Institute for Health and Care Excellence; 2014 Jan. 29 p. (Clinical guideline; no. 176). Electronic copies: Available in PDF from the NICE Web site .
- Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults. Costing template. London (UK): National Institute for Health and Care Excellence; 2014 Jan. (Clinical guideline; no. 176). Electronic copies: Available from the NICE Web site .
- Suggested written discharge advice card for patients aged over 16 years who have sustained a head injury. London (UK): National Institute

for Health and Care Excellence; 2014 Sep. 6 p. (Clinical guideline; no. 176). Electronic copies: Available from the NICE Web site .

- The guidelines manual 2009. London (UK): National Institute for Health and Care Excellence (NICE); 2009 Jan. Electronic copies: Available in PDF from the NICE Archive Web site .

Patient Resources

The following is available:

- Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults. Information for the public. London (UK): National Institute for Health and Care Excellence (NICE); 2014 Jan. (Clinical guideline; no. 176). Electronic copies: Available from the National Institute for Health and Care Excellence (NICE) Web site . Also available for download as a Kindle or EPUB ebook from the NICE Web site .

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This NGC summary was completed by ECRI on January 5, 2005. The information was verified by the guideline developer on May 11, 2005. This summary was updated by ECRI Institute on May 19, 2010 and May 5, 2014. This summary was updated by ECRI Institute on June 2, 2016 following the U.S. Food and Drug Administration advisory on Opioid pain medicines. This summary was updated by ECRI Institute on October 21, 2016 following the U.S. Food and Drug Administration advisory on opioid pain and cough medicines combined with benzodiazepines. This summary was updated by ECRI Institute on February 15, 2017 following the U.S. Food and Drug Administration advisory on general anesthetic and sedation drugs.

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